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[Tariq, Amina](#), Georgiou, Andrew, & Westbrook, Johanna  
(2012)

Complexity of collaborative work in residential aged care facilities: An analysis of information exchange for medication management. In  
Sprague, Jr., Ralph H. (Ed.)

*Proceedings of the 45th Annual Hawaii International Conference on System Sciences*, IEEE, Maui, HI, pp. 915-924.

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<http://doi.org/10.1109/HICSS.2012.170>

# Complexity of Collaborative Work in Residential Aged Care Facilities: An Analysis of Information Exchange for Medication Management

Amina Tariq<sup>1</sup>

Andrew Georgiou<sup>2</sup>

Johanna Westbrook<sup>3</sup>

Centre for Health Systems and Safety Research, Australian Institute of Health Innovation, University of New South Wales, NSW, Australia, 2052

{[amina.tariq](mailto:amina.tariq@unsw.edu.au)<sup>1</sup>, [a.georgiou](mailto:a.georgiou@unsw.edu.au)<sup>2</sup>, [j.westbrook](mailto:j.westbrook@unsw.edu.au)<sup>3</sup>}@unsw.edu.au

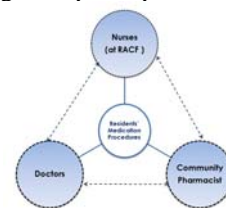
## Abstract

*Information exchange (IE) is a critical component of the complex collaborative medication process in residential aged care facilities (RACFs). Designing information and communication technology (ICT) to support complex processes requires a profound understanding of the IE that underpins their execution. There is little existing research that investigates the complexity of IE in RACFs and its impact on ICT design. The aim of this study was thus to undertake an in-depth exploration of the IE process involved in medication management to identify its implications for the design of ICT. The study was undertaken at a large metropolitan facility in NSW, Australia. A total of three focus groups, eleven interviews and two observation sessions were conducted between July to August 2010. Process modelling was undertaken by translating the qualitative data via in-depth iterative inductive analysis. The findings highlight the complexity and collaborative nature of IE in RACF medication management. These models emphasize the need to: a) deal with temporal complexity; b) rely on an interdependent set of coordinative artefacts; and c) use synchronous communication channels for coordination. Taken together these are crucial aspects of the IE process in RACF medication management that need to be catered for when designing ICT in this critical area. This study provides important new evidence of the advantages of viewing process as a part of a system rather than as segregated tasks as a means of identifying the latent requirements for ICT design and that is able to support complex collaborative processes like medication management in RACFs.*

## 1. Introduction

Healthcare systems across the globe are struggling to meet the needs of ageing populations [1]. Aged care is multidisciplinary and multiagency. It involves a complex interaction of physical, social, environmental, and economic factors that impact on the lives of older people and those who provide services for them [2]. The complexity of care delivery processes in residential aged care facilities (RACFs) is complicated further by the need for decision-making, communication, and information sharing that takes place using synchronous and asynchronous channels across multiple providers [3]. One of the most important coordination processes in

RACFs is medication management. This requires nursing staff, general practitioners (GPs) and community pharmacists to coordinate ordering, dispensing, administration and monitoring in an efficient and effective manner. Medication management involves carrying out high risk and time critical tasks by a team of care providers [4]. Quality medication management in RACFs is considered crucial to ensure residents' safety [5]. Studies in aged-care settings estimate that 42% of adverse drug events which include medication errors associated with the distribution and use of medicine are preventable [6]. Researchers have listed poor coordination between the participants of the medication management process as a prime reason for inefficiencies [7]. The coordination of the medication management process in RACFs is dependent on information exchange practices that are adopted to synchronize medication management activities. Information exchange practices encompass dynamics about how, when, what and where information is exchanged amongst the participants of the process.



**Figure 1: Three way communication in RACFs**

Information exchange practices in RACFs differ significantly from those in acute care patient settings. Two factors are distinctly different in RACFs. Residents have long term stays in a RACF, which may traverse many years, unlike acute settings where patients have short stays [8]. Further GPs and community pharmacists are major participants in residents' medication management but, unlike hospital staff, are not formally part of the RACF workforce [9]. GPs in RACFs see residents less frequently than doctors in hospitals, where patients are reviewed on a daily basis [10]. The role of GPs in RACFs has implications on the execution of medication procedures as prescribing and monitoring is frequently performed from a distance [11]. Also, in RACFs care is viewed as an ongoing process and ongoing renewal and review of prescriptions are a central responsibility. In RACFs the process for

ordering prescription refills—known as “renewals” involves complex three-way communication between RACF staff, the community pharmacist and doctors (Figure 1). Breakdowns in the information exchange process can lead to a lack of coordination and poor medication management [13]. Researchers have highlighted the potential role of information and communication technology (ICT) in facilitating inter-organizational care coordination [14]. However ICT adoption does not automatically fix the problem of information exchange [15]. ICT can be disruptive of existing workflows resulting in adoption of workarounds by the care providers which may introduce new risks to residents’ safety [16]. The successful adoption of ICT in RACFs implies a robust understanding of the workflow processes that the introduction of ICT is meant to assist. This point is highlighted by Mohamoud et al. whose report on the implementation of health information technology in long-term care settings in the US, concluded that it is the workflow which should drive design and implementation of ICT systems, not the other way around [17]. Thus a key requirement prior to the introduction of any type of ICT to support medication management in RACFs is the need to understand the dynamics of information exchange in the medication process. At present there is a very limited understanding of the roles that information exchange practices in RACFs play in supporting care coordination procedures like medication management. In the domain of aged care informatics, only a few studies have investigated the information exchange that underpins the inter-organizational processes [18, 19]. Existing studies on the use of electronic medication management systems in aged care are limited in terms of their focus on single organizations or individuals (GPs). Moreover, they do not address how ICT can be used by RACFs, GPs and community pharmacists to improve information exchange and better coordinate the medication process. [20-22]. This limited view of ICT as designed for single users, or for users undertaking discrete tasks in isolated “sessions” is misconceived and according to Karsh et al. [23] is the major reason for limited success of ICT in supporting complex healthcare processes. ICT therefore needs to be designed to support the information exchange for the entire medication process rather than facilitating it only in parts. Such design of ICT therefore requires an in-depth and holistic understanding of the existing information exchange practices that form the basis of care coordination [24]. This study presents an in-depth examination of the inter-organizational information exchange process that underpins the execution of medication management procedures in RACFs and identifies its implications for the design of ICT to assist the collaborative facets of the medication management process. The aim is to develop

an understanding of the information exchange process that can inform the design of ICT systems and facilitate improvements in the efficiency of the medication management process in RACFs resulting in improved resident safety and quality of care.

## 2. Research Setting

This study was undertaken in a RACF located in an outer suburban location in Sydney, New South Wales (NSW) Australia. The RACF is part of a not-for-profit church-based grouping. The participating site had a mixed resident population: 30 residents were classified as receiving low-level care (involving the provision of suitable accommodation and related supported living services such as cleaning, laundry and meals, as well as personal care services such as help with dressing, eating and toileting); and 48 residents receiving high-level care which covers accommodation and related living support services, personal care, nursing care and palliative care within a fulltime supervised framework [25]. The participating site described its ICT arrangements as a mixed system involving paper and ICT. All the key medication related procedures were paper based.

## 3. Research Methods

A total of 11 semi-structured interviews, three focus groups and two observation sessions were conducted over a period of two months from July to August 2010. A pilot test of the interview questions was conducted with one of the managers and a care staff member to evaluate the adequacy of the language and scope of the interview questions. The interview questions were revised based on the results of the pilot tests and follow up discussion with the research team. All participants in the study were provided with a verbal introduction to explain the purpose of the study in a participant information session conducted at the site. Semi-structured interviews were conducted using a standard set of open-ended questions to enquire about information exchange for the execution of medication processes in RACFs. Purposive sampling techniques [26] were used to extend the participant base to include a cross section of RACF staff including managers, GPs, nurses and carers (Figure 2).

Data Collection Summary	
Number of interviews and/or observations 11	Number of focus groups 3 (n=15)
(1 Director of Nursing, 3 RNs, 2 GPs, 2 allied care staff, 4 RACF staff members)	# of participants per group:5 Participants included RNs, RACF managers and allied health staff

**Figure 2: Data Collection Summary**

The selection technique aimed to provide a diverse sample of participants covering a range of perceptions to explore the details of the medication process being

undertaken in the facility. All interviews and focus groups were recorded using a digital voice recorder and were later professionally transcribed. The interviews and observation sessions lasted for an average of 20 minutes and focus groups lasted an average of 34 minutes. To analyse their role in the medication process we also examined the artefacts (documents, forms, notes etc) used on regular basis to support task execution. The artefacts were mainly paper based (including primary medication charts, signing sheets, GP's medical notes and staff progress notes). These artefacts were accessed through both the interviewees and the RACF management staff.

#### **4. Data Analysis**

The analysis was carried out using rigorous iterative procedures. NVivo software was used to support inductive qualitative data analysis [41, 42]. The data obtained from interviews, focus groups and observations were analysed using a grounded theory approach and iteratively discussed in regular research team meetings in order to identify emergent themes, clarify inconsistencies or unusual findings, and as a basis for planning subsequent interviews and observation sessions [42]. Analysis of interview and observation data enabled identification of the dynamics of the routine medication procedures including pre and post prescribing activities and activities in relation to medication ordering, medication administration and medication monitoring. The analysis also revealed how the RACF deals with non-routine events (incidents like falls etc.). To facilitate in-depth understanding and analysis of the complex process, the information gathered was used to develop process models representing the activity and artefact flow in the medication process following the healthcare activity modelling approach suggested by Jun et al. [30] and Doherty et al. [36]. The models facilitated the capture of the dynamics of complex processes and enabled identification of inter-linked issues involving tasks, people and information to support further analysis [29]. Process models were developed using Business Process Management Notation (BPMN) [27, 28]. The rationale for using BPMN was the need to present a full picture of the complex adaptive and dynamic nature of the medication process [28]. Activities within the RACF are shown in the same pool and interaction with different stakeholders outside the RACF is described by message arrows across pool borders. This design feature facilitated the clarification of responsibilities and ensured representation of all instances of information exchange at all levels [31]. Coding was then iteratively refined and linked into an axial coding system that highlighted relationships and consistent patterns within the data [42]. A research log was also used to document findings and suggestions as the study progressed. The

log was thus able to provide an audit trail of the research process while simultaneously guiding the direction of the research [43]. For validation purposes a workshop was conducted to confirm the findings and correctness of the process maps. The workshop involved 8 participants (including representatives from the study site and aged care nursing staff from some non-participating sites) and deliberated on the face validity of the study findings. The process models and the subsequent analysis were revised after the validation workshop. This was followed by an analysis of latent requirements for the design of ICT to support the complex collaborative aspects of the medication processes.


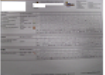

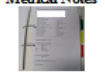
#### **5. Medication Management Process**

The analysis of interviews and observations revealed four major stages of the medication process which are driven by intense information exchange. These stages include preparation for medication rounds (pre-prescribing activities), medication rounds (prescribing procedures), medication ordering and dispensing and medication administration (Section 5.1-5.4). Each stage has distinct information exchange requirements which are met by sharing of various artefacts that coordinate activities among the participants of the care team involved in medication management. Table 1 presents an overview the key coordinative artefacts shared among the care team for residents' medication management process. This understanding of artefacts facilitated the development of a stage wise description of the process discussed below.

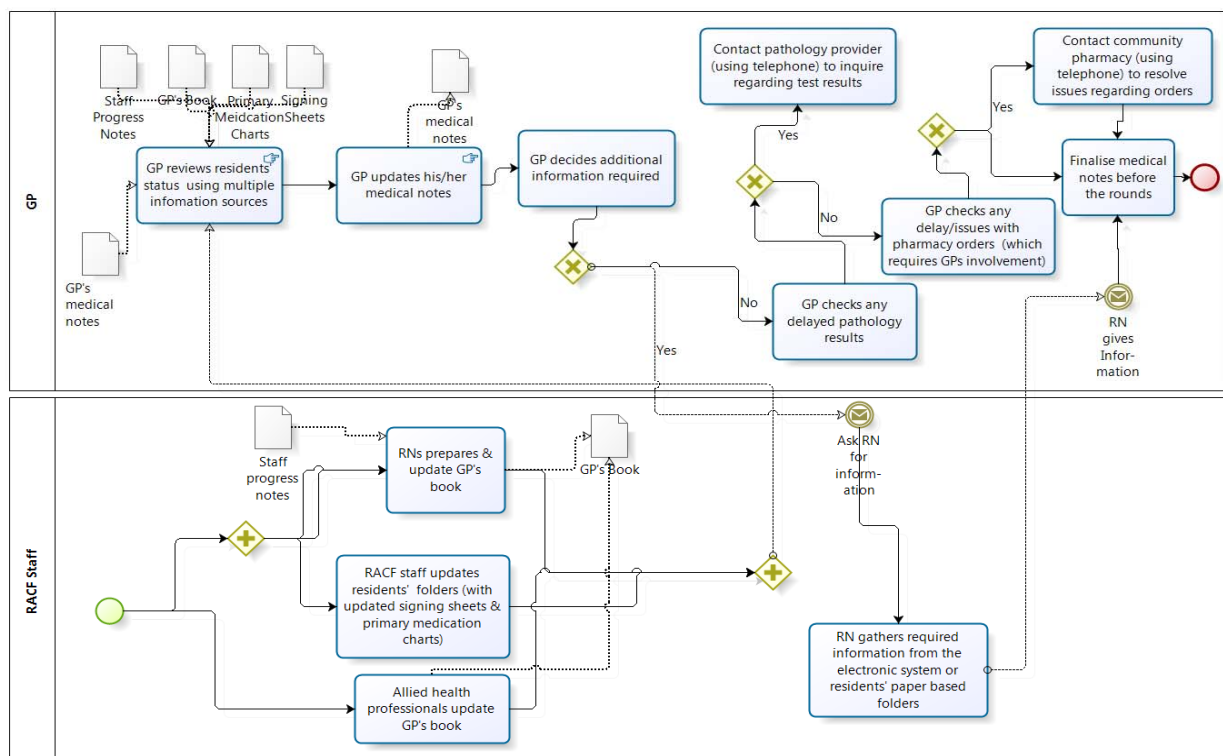
##### **5.1 Pre-Medication Round Procedures**

Medication management in RACFs involves procedures in relation to the preparation for weekly GP medication rounds; which in the context of this study are classified as pre-medication round procedures. The activities of this stage are mainly carried out within the RACF, and require input from the registered nurses, allied health staff and GPs who record information relating to the residents' condition that may influence prescribing decisions in the upcoming weekly medication round. Figure 3 presents a detailed view of the activities performed during the pre-medication round stage. These activities include the preparation of the GP's book prior to the GP's weekly medication round. The GP's book contains notes, entered by RNs between the weekly medication rounds with general queries/concerns about residents. The facility in this study had two GPs who visit on weekly basis, each has his/her own book. This book plays a vital role during the weekly rounds as the GP uses it to: a) place reminders to help in the examination of residents during rounds; and b) for writing prescriptions after the rounds.

**Table 1: Summary of Artefacts**

Key Artefacts	Role in Medication Process
<b>Primary Medication Chart</b> 	This is the key formal artefact in residents' medication process. Doctors record the details of required new medicines or any changes in medication on this chart and sign it. Each resident has his/her own medication chart. It acts as a coordinative information artefact between pharmacy, doctors and the RACF. The RACF needs to fax it along with the order form to the community pharmacy. The pharmacy keeps a copy of this chart and dispenses medicines along with the signing sheets.
<b>Signing Sheet</b> 	This is the second important formal artefact which is sent by pharmacists along with the medications to the RACF. The sheet consists of dates (for 30 days) along with the list of medications. Once the medication has been administered to the resident the signing sheet must be signed by the RACF staff as documented evidence of administration. It is kept in the resident's folder after its completion for 6 months before being archived. New signing sheets are obtained from the pharmacy upon completion of the monthly signing sheets.
<b>Webster Packs</b> 	The community pharmacist dispenses medications into a Webster pack which consists of pre-packaged individual doses of each resident's medications. Each resident has his/her own of Webster packs which sets out all the medication that need to be taken at each particular time of the day, for each day of the week. These packs are securely sealed to protect the medication and to avoid the possibility of spilling or mixing up medications by RACF staff.
<b>Doctor's Book</b> 	This is a notebook in which nursing staff write questions to the doctor regarding residents' medications. This book is reviewed by the doctor at the weekly medication round. During medication rounds doctor also enter reminders about residents medication needs. This information is then used to assist in the medication ordering process after rounds.
<b>Doctor's Medical Notes</b> 	These consist of doctors' notes regarding residents' medication, and pathology reports, and consultant referral letters (if any). These notes also consist of any queries made by allied health professionals (including physiotherapists and dieticians). These notes remain within the RACF and are used by RNs and allied health care staff to support their resident care related activities. They form part of a resident's formal medical record.
<b>RACF staff Progress Notes</b> 	These are the prime coordinative artefacts for medication activities within the RACFs and are a vital information resource during the handover process. RACF staff record medical directives, eg. any increase or decrease in medication dosage and reasons for these changes in the progress notes. RNs record updates of their conversations with the doctors during the week in their progress notes as well.
<b>Residents' Medical Folders</b> 	These are mainly used to store the recent documentation related to the residents including medication. Each resident has his/her own file consisting of their recent care details. Once a signing sheet is completed, it is transferred to the residents' folder for six months before being archived. Old primary medication charts are also placed in this folder for six months before being archived.

The GP's book remains in the RACF and is used by the RNs as a reference for resident care and information exchange with other staff members. Allied health professionals such as physiotherapists or dieticians can also may entries in this book for the GP regarding issues they think will have an impact on the GP's prescribing decisions. Along with these books, GPs also refer to their medical notes that are held by the RACF. These notes include the details of the medication they have prescribed, pathology results and consultants' letters. The other artefact that is continuously updated during the week by the RACF staff is their progress notes. Here nurses will record any conversations they have had with a GP during the week. For new residents, GPs require their full medical history including information measures such as blood pressure and sugar levels for residents with diabetes. When the GP arrives for the weekly medication rounds he/she firstly reviews residents' medication charts, staff progress notes, the GP's book. Key information from these sources is then transferred to the GP's own medical notes. If test results are not available the GP will telephone the pathology provider. If medication orders have not been filled the GP may contact the community pharmacy directly via the phone to enquire about their status. If additional information is required prior to the rounds GPs engage in face to face communication with RNs, who might be able to answer instantly or may be required to gather information from other information sources in the RACF.



**Figure 3: Pre-Medication Round Procedures**



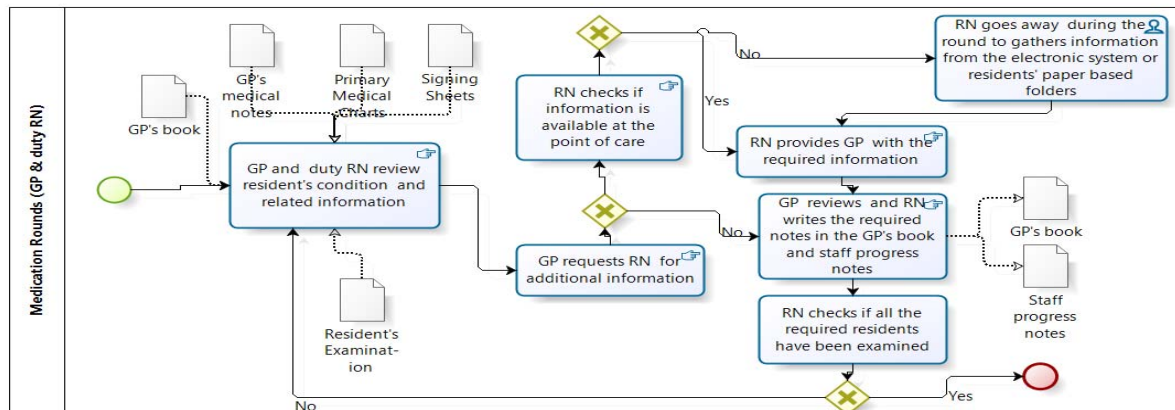


Figure 4: Medication Rounds

## 5.1 Medication Rounds

An RN accompanies the GP on the weekly medication round. The artefacts carried during the round include the GP's book, GP's medical notes, residents' folders and latest signing sheets for reference. The documentation collected during the round includes referrals, reminders for prescriptions (eg, if the GP wants to start a new antibiotic or replace a medication) which are recorded in the GP's book by the GP during the round. The GP and RN also engage in verbal conversation at the point of care in situations where the GP needs more information

regarding a resident's activities during the week. In exceptional cases, if the GP requires any additional information not available at the point care an RN might need to retrieve it (from the electronic system or manual folders) and bring it back to the GP. Figure 4 presents the process map for medication rounds in the RACF.

## 5.2 Medication Ordering & Dispensing

After completing the weekly medication round, the GP along with the duty RN sequentially reviews residents' cases in a briefing session in the GP office, using

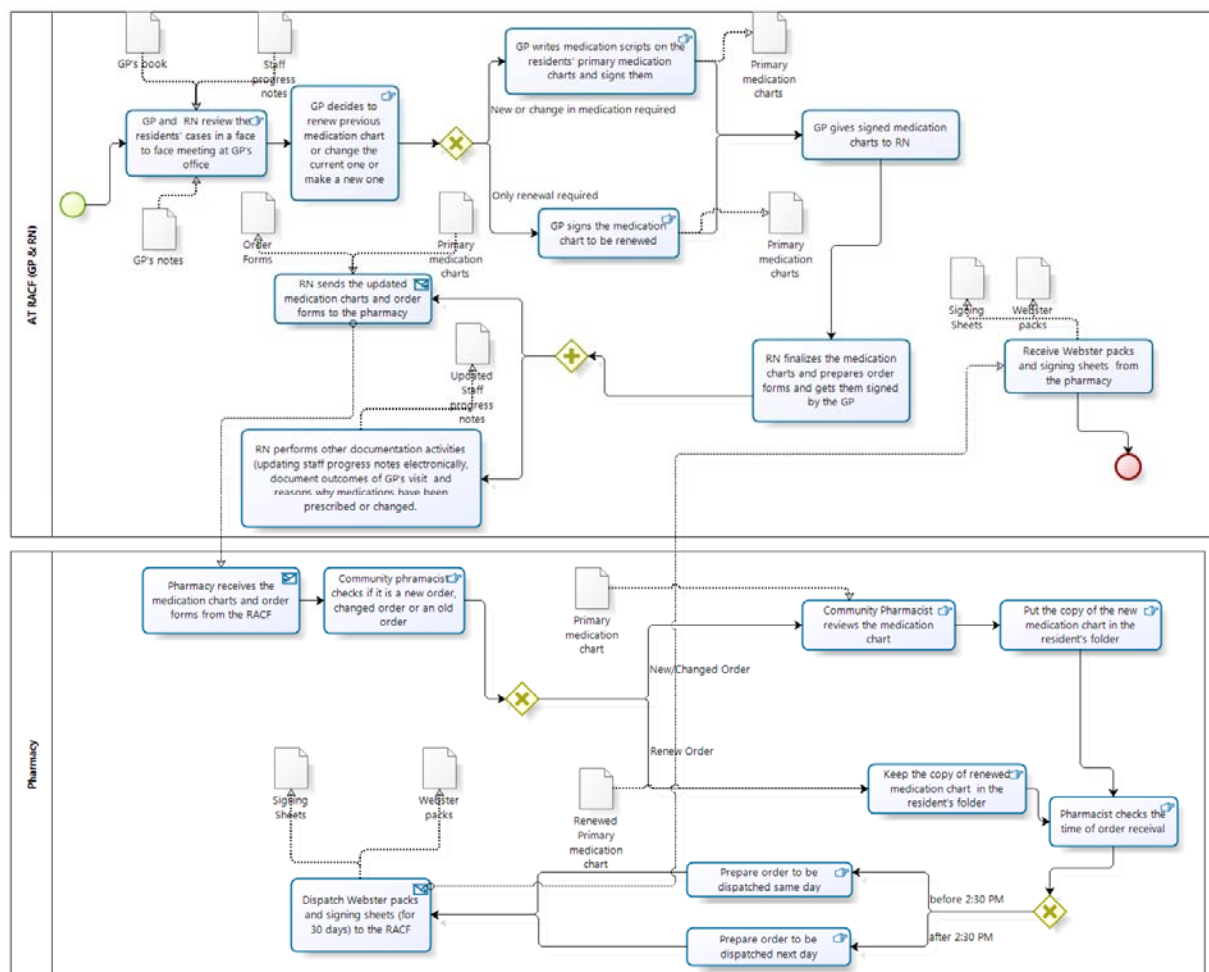


Figure 5: Medication Ordering & Dispensing

information collected during the round (reminders in the medical book, progress notes, GP's medical notes etc) and other supporting information in the GP's medical notes (medication information, pathology results and consultant letters). The GP then prepares the primary medication charts for the residents and signs them. The primary medication chart is the key formal artefact in the residents' medication procedure. Each resident has his/her separate primary medication chart. Any new medication or changes are recorded by the GP on this chart which requires an authorized signature for further processing. If a medication renewal or a new signing sheet is required then the GP signs the new medication chart for the resident. The RN takes the primary medication charts of the residents and prepares prescription order forms by manually transferring information from the charts to the order forms. These forms are then signed by the GP and the RN sends both the order forms and medication charts via fax to the relevant community pharmacy. The RACF in this study had one main pharmacy as their medication provider. The RN also performs a number of documentation activities which include updating staff progress notes electronically, documenting the outcomes of the medication rounds and recording reasons why medications have been prescribed or changed in their progress notes as shown in the process map in Figure 5.

At the pharmacy, the community pharmacist reviews each of the received primary medication charts. If it is a new or updated medication chart; the pharmacist places a copy in the respective resident's file (consisting of previous medication charts) stored at the pharmacy. The community pharmacist then arranges for packaging of medicines as per the prescription order form. The medication is packaged into Webster packs (see Table 1) and dispensed along with the signing sheet(s) to the RACF. The signing sheet is the second important formal artefact which is sent by the pharmacists along with the medications to the RACFs. The sheet consists of dates (for 30 days) along with the list of medications. After medication administration, RACF staff needs to sign the sheet, and record the dosage details of medication administered to residents. The sheet is also used to maintain a record of missed dosages (for example if a patient was unable to take a dose of a prescribed medication for some reason). For each new medication prescribed for residents, the pharmacy will send a new signing sheet for that medicine as shown in Figure 5. Pharmacists review the medication charts and send a new signing sheet to the facility every 30 days. In case of a delay in arrival of a new signing sheet RACF staff administering medicines need to document all the details of the given medicines in their staff progress notes. Primary medication charts are renewed every six weeks. The GP is required to review all the re-written

medication charts (and check that are correct) and sign them. The renewed medication charts are then faxed to the community pharmacy. Old medication charts and signing sheets are archived in the residents' medication folders. If the RACF sends the prescription order forms before 2:30 pm (during morning shift) the pharmacy dispenses the medicine to the pharmacy by 5:00 pm at the latest on the same day.

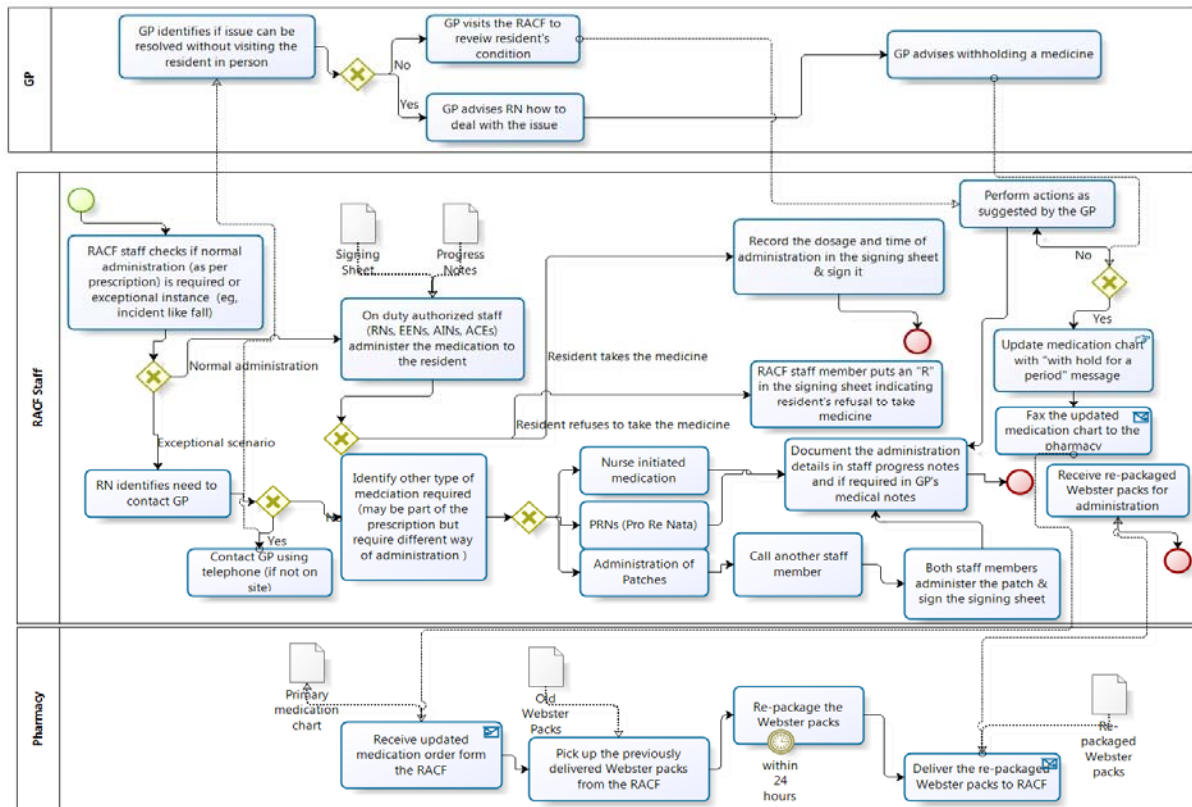
### 5.3 Medication Administration

The next important stage in the medication management process is the actual administration of the medicines to the residents. Figure 6 presents the process map for the major activities executed in the facility for administering medicines. Within the facility registered nurses (RNs), endorsed enrolled nurses (EENs), qualified Assistants in Nursing (AINs) (with certified training in medication administration) can administer medication to the residents. They have to sign the signing sheet at the time of administration. The information recorded in the signing sheet includes the medicine given and its dosage (eg, number of tablets). In any cases where the resident refuses to take medicine the responsible staff needs to document this by placing an "R" in the signing sheet, indicating that the resident refused to take the medicines. In some instances RNs might need to administer medicines which are not part of the normal course of prescription which include Nurses Initiated Medication and Pro Re Nata (PRN) which are medicines given to the residents only as needed (eg, pain medication) [33]. Administration of patches (delivery of medication through skin) requires at least two authorized staff members for administration. Both the RACF members are required to sign the signing sheet [33].

In emergencies the RN on duty can contact the GP via telephone and explain the situation to get his/her recommendation and update their progress notes accordingly. If the situation cannot be handled on the phone the GP will organise a visit to the facility. In a scenario where a medication needs to be withheld for a period as suggested by the GP, the RN faxes the medication chart to the community pharmacy with a message stating "withhold for a period". If required, the pharmacy picks up the already delivered Webster packs, repackages them according to the revised medication chart and sends them back to the RACF within a 24 hour period.

## 6. Implications on ICT Design

The above in-depth investigation of the medication management process in an RACF emphasizes the extremely distributive and collaborative nature of the work [34]. We identified three major dimensions that require special attention when designing ICT to assist



**Figure 6: Medication Administration**

the collaborative aspects of information exchange in complex inter-organizational processes like medication management in RACFs.

## 6.1 Temporal Dimension

The medication management process is based on nursing staff operating on a three shift basis (day, evening and night shift) and GPs under normal circumstances coming on a weekly basis. Therefore the care of residents has to be planned and executed across these four shifts of participants. Different stages of the medication management process have their own associated time spans. For instance medication administration, which is a key responsibility of authorized staff in the RACFs, is usually achieved on a day-to-day basis across the three shifts whereas medication rounds which involve doctors are normally done on a weekly basis.

The above process analysis highlights the use of artefacts to support this temporal division of the medication work. For instance medication administration for the residents is performed by nurses across shifts. Nurses use a signing sheet sent by the pharmacy to record the medication administration information. The signing sheet therefore acts as a cognitive artefact to: i) support individual tasks of the staff; and ii) support distributed cognition by holding status information about residents to be shared with

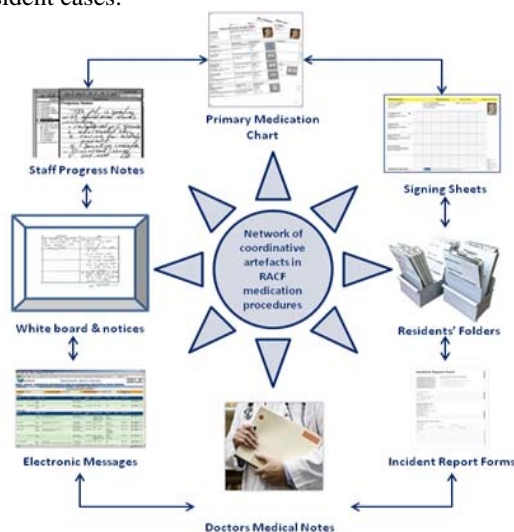
other staff members, the community pharmacist and the GP. In this way the signing sheet is shared across shifts within the RACF and with the GP to review the progress of the resident during weekly medication rounds. Once completed (after 30 days) it is used as a reference to get a new signing sheet from the pharmacy. This understanding of the chronological flow of information therefore facilitates the identification of how to present information at different stages of the process to different stakeholders [36]. The knowledge of temporal patterns has several implications for the design of ICT, as understanding these patterns allows the development of information models that provide features in the system that support the execution of activities according to the temporal stage of the process [35]. For instance as doctors perform weekly rounds it would be practical to give them the sequence of only relevant events rather than providing them with details of all the activities performed in the RACF during the week.

## 6.2 Formal vs. Informal Artefacts

While residents' primary medication charts and signing sheets remain the key coordination artefacts for their long-term care planning, there are less formal but more important artefacts that are required for daily coordination of medication procedures between RACF staff, GPs and pharmacies. These complementary artefacts facilitate day-to-day coordination and allow the



identification of changes in long-term care plans for the residents. Complementary artefacts included staff progress notes, whiteboard and notices, electronic messages, incident forms, GP's book, GP's medical notes and residents' archived medical folders as indicated in Figure 7. Apart from staff progress notes all the other artefacts were paper-based and shared based on verbal communication by the participants of the process. The use of personal paper artefacts which include nurse's progress notes, incident information reports and the GP's medical book requires both RNs and GPs to relay information verbally when discussing resident cases.



**Figure 7: Network of Coordinative Artefacts**

This exchange of information is vital to completing the medication tasks with shared understanding. Despite sharing similar information there are some differences in the information and physicality of the artefacts which reflect the differences in their intended purpose. For instance the GPs are mainly interested in the status of the residents which they obtain by exploring the GP's medical book, staff progress notes, GP's medical notes, residents' medication charts and their signing sheets. RNs use similar artefacts to execute their tasks related to residents' medication, for example ordering new medications or following up (getting Webster packs re-packaged due to changes in medications). Another relevant example is the use of a primary medication chart where the GP formally documents their prescriptions. This is used by the nurses for care planning, ordering medications and monitoring medications over a period of time; and by community pharmacists as a reference sheet to formulate and dispatch orders and signing sheets to the RACF. This distinction in the purpose of different artefacts can be attributed to the need to view information differently at distinct stages of the medication management process.

For example signing sheets are used as a means to view medication administration status of residents' on day to day basis, as well as serving the purpose of communicating residents' status to the GPs. Artefact analysis therefore indicates the need to identify how different electronic representations of information can facilitate the individual tasks of different user groups and for developing a shared understanding amongst participants. Therefore a major design concern when digitizing coordinative artefacts is the recognition of dependencies and ensuring that connections between artefacts are maintained or developed [37]. ICT design also needs to identify the right level of artefact standardization for digitization that allows staff to personalize their informal artefacts such as annotating progress notes and using abbreviations instead of complete terms [38].

### 6.3 Heterogeneous Communication Channels

Findings from the process analysis reveal that communication to coordinate the inter-organizational activities in the medication procedures primarily relies on synchronous communication channels which include both face-to-face and telephone conversations. Participants emphasized the need to have a secure communication mechanism and therefore preferred synchronous over asynchronous communication channels. External communication with key providers such as GPs, pharmacies, pathology services and allied health staff involved telephone calls (verbal conversations), text messages and emails (for receiving pathology results) as shown in Figure 8. The artefacts used to support the *internal* communication activities in RACFs include care plans, handover meetings, progress notes and diaries and memos. The findings indicate the vital role played by the face-to-face communication between the duty RN and the GP in prescribing decisions during the medical rounds. The majority of the decisions on changing medications are made during these rounds. The RN adds these notes as reminders into the GP's book which are then used as reference information while preparing the medication charts after the rounds. These medication rounds and exchange of verbal information serve as the basis of developing shared understanding between the RN and the GP of the medication plan for the residents. Therefore both these groups are dependent on synchronous communication. Any ICT system that forces the participants to adhere to rigid communication procedures which inhibit the informal practices that the team is accustomed to as reported in studies in context of hospitals can result in disruption of activities in the work process [39]. For instance, enforcing the GPs to use an ICT system to find information rather than asking RNs directly could be detrimental to the time dimension of the process as presently GPs expect to get certain information about

residents from RNs. Formalising communication procedures between RNs and GPs therefore may impede discussions which are critical to diagnosis and prescribing decisions, and which may have a direct impact on resident care. The analysis therefore emphasises the development of an understanding of where (point of care, remote access etc) and when (which stage of the process) ICT can support information access to the participants of the process. Therefore, to support the communication dimension of information exchange ICT systems need to cater for the individual as well as team communication preferences [40].

Communication Channels	Used By
<b>Synchronous Channels</b>	
Face to Face Conversation	Registered Nurse ↔ Doctor(s) Registered Nurse ↔ RACF Staff Registered Nurse ↔ Allied Health Professionals
Telephones	Registered Nurse ↔ Doctor(s) Registered Nurse ↔ Pharmacy staff Doctors ↔ Pharmacy staff Doctor(s) ↔ Pathology staff
<b>Asynchronous Channels</b>	
Fax	Registered Nurse ↔ Pharmacy staff
Email	Registered Nurse ↔ RACF Staff Registered Nurse ↔ Allied Health Professionals
Text Messages (Electronic)	Registered Nurse ↔ RACF Staff
Text Messages (Paper based)	Registered Nurse ↔ Doctor(s) Registered Nurse ↔ RACF Staff Registered Nurse ↔ Allied Health Professionals Doctors ↔ Allied Health Professionals

**Figure 8: Heterogeneous Communication Channels**

## 7. Discussion

The analysis outlined above offers an in-depth understanding of the information exchange that underpins medication management processes in RACFs. This study offers three key contributions to the existing aged care informatics research. Firstly, it describes how in-depth modelling of information exchange in complex healthcare domains like aged care can facilitate an understanding of coordination requirements of aged care processes. Our iterative data collection and sophisticated modelling provided a useful conceptualisation of the multi-dimensional nature of coordination in RACF medication management. Our analysis also highlights the importance of coordination between activities (monitoring residents, reporting incidents, ordering and receiving medication), different professional disciplines (doctors, nurses, pharmacists etc) and different working shifts. Therefore any ICT system that is conceptualized as linear, stepwise and unidirectional, with GPs having the central role, will not be able to support the complex coordination requirements of the medication management tasks in the RACFs. Secondly, the findings highlight how a holistic examination of the process leads to identification of the latent requirements for ICT design for collaborative work in complex domains like healthcare. The analysis

indicates that ICT needs to support the creation of shared information artefacts; their accessibility to all concerned stakeholders at the right stage of the process. ICT design needs to be informed by the actual structure and interdependencies between the artefacts used to support information exchange process. The final key contribution of this study is the use of empirical evidence to identify how the geographically dispersed care team relies on heterogeneous information exchange mechanisms attributed to their personal preferences as well as their habituated work practices. This indicates that participants of the process have the option to tailor technology to fit their present information exchange practices. For instance RNs interact with ICT through paper print outs of their progress notes which they annotate during the medication rounds. This supports their communication with GPs. It is vital to consider the real world interaction practices of different user groups. This is a means of informing ICT designs. Doing so can ensure the implementation of the right degree of standardization for information exchange practices without introducing rigid communication structures which can result in disruption of existing coordinated workflows.

## 8. Limitations

This study relied on data gathered from a purposive sample of staff from one site. However the in-depth descriptions of the medication management process using elaborated maps were presented to an expert panel from aged care nursing staff from some non-participating sites as a key validation procedure to enhance the applicability of the findings across settings. Future studies focusing on use of ICT as an intervention and comparing the results with the traditional paper based procedures based on quantified measures like time spent on each activity and process as a whole can provide evidence on how and where ICT improve the medication management in RACFs.

## 9. Conclusion

To our knowledge this study is one of the very few studies that explore the complexity of inter-organizational information exchange in RACFs. Despite its focus on one site, the detailed mapping of the medication management process using evidence collected from multiple data sources enabled identification of latent requirements of ICT design, in particular to assist the collaborative dimension of the medication management process in RACFs. This study identifies temporal distribution, reliance on a network of artefacts and use of heterogeneous communication channels as key facets of the inter-organizational RACF information exchange process for coordinating residents' medication procedures. Any ICT solution that

aims to facilitate information exchange in RACFs therefore needs to take into account these aspects in its design to ensure alignment with the existing workflows without compromising residents' safety.

**Acknowledgements:** This study was funded by the NHMRC program grant ID No. 568612 which aims to examine patient safety across different health sectors in Australia. The program grant is being administered by Australian Institute of Health Innovation (AIHI). We thank RACF staff and management for their participation and collaboration in this study.

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